ENGINEERING NEWS.

Tribune Building, New York City.

GEO. H. FROST, PROPRIETOR.

SATURDAY, OCT. 1, 1881.

THE AMERICAN SOCIETY OF CIVIL ENGINEERS.

The above named society has its headquarters in it own building, 127 East Twenty-third street, New York City; its officers for the year commencing Nov. 3, 1880, are Jas. B. Francis, of Lowell, Mass., President; O. Chanute, of New York, and Ashbel Welch, of Lambertville, N. J., Vice-Presidents; John Bogart, Secretary and Librarian; J. J. R. Croes, Treasurer; W. H. Paine, C. Vandervoort Smith, Jos. P. Davis, G. Bouscaren and D. J. Whittemore, Directors. The regular meetings of the society are held on the first and third Wednesdays of the month at 8 p. m. The rooms of the society are open from 9 a. m. to 5 p. m. every business day, except Saturday, when they close at 3 p. m. They are also open every Wednesday evening from 7:30 to 10 o'clock. The 29th annual meeting will be held in this city on Jan. 18, 1882.

Civil, military, geological, mining and mechanical engineers, architects, and other persons who by profession are interested in the advancement of science, are eligible for admission to the Society. Members are classed as members, associates and juniors; the two last are not allowed to vote. A member shall be a civil, military, mining or mechanical engineer, who has been in active practice as such for seven years, or has graduated as civil engineer and been in practice for five years, and has had responsible charge of work as chief, resident, or superintending engineer for at least one year; not as a skillful workman merely, but as one qualified to design as well as to direct public work.

An Associate shall be a manager of a railroad, canal, or other public work; a geologist, chemist or mathematician; a proprietor or manager of a mine or metallurgical works; an architect or a manufacturer, or one who, from his scientific acquirements or practical experience, has attained eminence in his special pursuit, qualifying him to co-operate with engineers in the advancement of professional knowledge; but shall not himself be practicing as an engineer.

A Junior shall be one who has had actual practice in some of the branches of civil, military, mining, or mechanical engineering, for not less than two years; or, if a graduate of a scientific or collegiate institution, for not less than one year.

A person to be eligible to any class of membership must not be less than twenty-one years of age.

Nominations and proposals for admission to the Society shall be indorsed by at least five members, who certify that they personally know the nominee or candidate, and that he is worthy of acceptance. The proposal of Member, Associate or Junior shall contain a statement, over the candidate's signature, of his age, residence, the nature and term of his professional service, and that he will conform to the requirements of membership, if elected.

Candidates are elected by ballot. Five negative votes exclude from membership. Resident members are such as live within fifty miles of New York City; non-resident are those who reside without this limit. The dues and fees are as follows:

Dues.	Resident.			Non-Resident.		
	Members.	Associates	Juniors.	Members.	Associates	Juniors.
Entrance fee.....	$30.00	$20.00	$20.00	$30.00	$20.00	$20.00
Yearly Assessment.....	25.00	20.00	15.00	15.00	10.00	10.00
Payable upon election.....	55.00	35.00	35.00	45.00	30.00	30.00

Fellowship fees, $150. All remittances should be payable to the order of the Treasurer of the Society, and be in drafts on New York or postal money orders.

At the close of the year ending Nov. 3, 1880, there were 611 persons connected by membership with the society; of these 427 were non-residents. At the same date the society possessed a library containing of books and pamphlets 8,738; manuscripts, 105; maps, plans, drawings, charts, photographs and engravings, 2,114; models and specimens, 230. Of this library a very complete catalogue is in process of preparation, the first division, devoted to railroads, being already published. The financial condition of the Society is exceedingly satisfactory; its receipts are growing in amount each year, and are so largely in excess of expenditures that there is annually an unexpended balance for investment. The Society having outgrown its house accommodations, action was taken last year to provide more spacious and convenient permanent quarters. The result was that subscriptions to a building fund having been solicited, a sum was realized, and the prospects for the full payment of the amount considered so favorable that in April last the present house was bought for $30,000, of which nearly one-half is already paid. Subscriptions are invited on the following terms: Any person paying $100 will be listed in the catalogue of members hereafter under the head of "Subscribers to the Building Fund," and will be entitled to one copy of the Society's Transactions, sent to him regularly for life. Already quite a number of subscriptions have been made by persons not members of the Society, and it is hoped that this number will be largely increased. The papers read before the Society are published monthly; they are carefully edited by the Secretary, are fully illustrated, and each year form a volume of valuable engineering information, which, being the result of personal experience, forms a valuable addition to a professional library. What the custom of the Society is with regard to disposing of any extra copies of their publications is we do not know, and for such information we refer parties wishing it to Secretary Bogart.

The Society is the headquarters for engineers and engineering literature in America; it has already established a status for American engineers, who may well consider it a privilege to be classed in its list of members; it has accomplished much that is beneficial to the profession, and in every respect it deserves the constant and earnest support of every American civil engineer.

THE PANAMA CANAL.

The Panama Canal enterprise continues to be subject to a great deal of criticism. Some of these strictures are unmerited, for it is manifestly unjust to render M. Lesseps responsible for the exceedingly unhealthy climate of the isthmus.

The following detailed report of the doings of the company so far, and of the nature of the difficulties with which the engineers have to contend, is taken from French sources, and although it may be considered as a one-sided account, which it evidently must be, there is no reason to believe the statements contrary to facts. The complaints made against the company were: That no survey had been made; that no works had been carried on; that no material had been received; and that the employés were badly housed and fed, and not paid, and that, finally, there were no hospitals or proper medical attendance.

In answer to such attacks, which the French writer takes up *seriatim*, it is observed that the company was legally constituted on March 4 of the present year, and that no contracts could be entered into before that date. The contract was only signed in June, and finally reached the company on July 24.

If engineers were sent out last January this was simply owing to the enterprising initiative of M. Lesseps alone.

So far as the surveys are concerned, the base selected for them was the Panama Railroad, and a complete planimetric plan was made of the line.

An exact leveling of the line marked out by corner stones has been also made. The luxurious vegetation of the isthmus was found a great hindrance in taking the leveling of the axis of the canal. The ground is so covered with wood that a way had to be cut out with the hatchet. On the side of Colon, Mindi, Gatun and Frijole, marshes add to the difficulty. In order to obtain an exact idea of the surface, some 200 kilometers were cut out transversely to the axis of the canal and leveled, while a passage of from 20 to 30 meters was cut from one side to the other of the isthmus, according to the tracing of the Canal Commission.

In the hilly part of the isthmus, between Paraiso and Matachin, the clearings are at distances of 122 meters; between Emperador and Obispo they are only 50, and at Gatun 30. Owing to this work, level curves have been taken over a superficies of about 56 square kilometers.

The plan of Panama, and between Panama and the mouth of the Rio Grande, the course of the Upper Chagres for more than 45 kilometers, and of the Lower Chagres for 70 kilometers, have been taken. Also, complete hydrographical plan of the bay of Colon, with careful soundings over the whole bay; and of the Rio Mindi, from its mouth to the railway.

The surveys for damming the Chagres at Gamboa are already in a very advanced state, and are being carried out energetically. Four meteorological stations have been established—at Colon, Gamboa, la Boca del Rio Grande, and in the Isle of Nars.

A fluviograph has been put at Gamboa.

All the geological soundings, which are of the greatest importance for locating the extent of the rocky part, and obtaining a knowledge of the proportional cube of hard and soft rocks, etc., were begun at the very outset.

There are now 22 of those soundings, including two large steam soundings, which are kept working at the highest points of the line—at the neck of the Culebra—at altitudes of 72 and 95 meters; 7 other soundings worked by hand, at depths of from 40 to 60 meters, between Matachin and Paraiso—three are already finished. Ten soundings between Gatun and the sea have given the geological cropping of that side of the isthmus, and have shown that there was no rocky part to be cut between Colon and Lion Hill. The neighborhood of Panama was surveyed by five soundings, one of which was in the sea.

As far as the embankment and cutting are concerned, large section wells (108 square feet) have been sunk, and finally the map of the geological section has been made for the entire line of the canal, with the addition of some kilometers to the left and right.

Two more steam sounding apparatus, similar to those at Culebra, are also being prepared.

At that station the specimens of the soil which were brought up by the scoops afforded a means of obtaining a knowledge of the structure of the

ground—a succession of argillaceous layers, showing a decomposition of a greenish rock. The important geological fact is that, instead of successive formations, there is a compact mother rock at the bottom, and from thence to the summit, a succession of dermatine rocks, which become gradually softer. The soundings have in fact given results surpassing all expectations.

An excavator will soon leave Colon for Gatun, and another is being made at Gatun. The cutting of the canal will be begun at once. Two hundred wagons, 12 locomotives, 2 pontoons, 2 steam cranes, 2 dredges, with double apparatus; steel ribbons, rails, etc., are either in Colon, or on the way thither.

The workshops, at Colon, covering an area of 14,000 meters are full. Two boats and two steamboats run on the Chagres. Another steamboat is at Panama, employed in the hydrographical surveys. Everything is ready at Gatun for having a large interior port. There, too, all the earthworks are finished, and a whole village constructed by Mr. Huerne, of San Francisco, is expected, while orders for houses for various other points are being executed in the United States.

The complaints made as to food, etc., are denied. The pay is the same given by the Panama Railroad and the Maritime Companies of the isthmus.

The hospitals are being constructed, and in the meantime arrangements have been made with the Strangers Hospital at Panama.

MOVABLE SCAFFOLDING FOR LAYING BETON BLOCKS.

The moles at the mouth of the Amsterdam Canal require enormous blocks of béton. A movable scaffolding, the principal features of which are shown in Figs. 1 and 2, was employed for the purpose.

The lower housing rested on eight blocks and had a circular platform 8 m. in diameter at a height of 5.50 m. above the rails. The upper part of the scaffolding was pivoted on this platform, which was furnished with a tram-rail. This portion of the scaffolding rested on a pivot on the center of the circular way, and was composed of two gallows stayed together by cross-pieces. Attached to those gallows are metallic braces supporting the floor of the bridge. The steam engine, which works the crane and serves as a counterpoise, is protected by a wooden shed, and is at the end of the floor. The back part of the floor has a length of 16.60 m., of which 15.50 m. are available for working, and is composed of two beams supported by braces, and has a small railway on which a small cradle circulates. The blocks are hung from the latter. The blocks are brought on the trams under the housing which supports the crane. They are then raised vertically by means of the cradle, and taken to the end of the working bridge; that is, above the spot where they are to be placed. All the movements are made by chains from the machine. The rotation of the working bridge is also given by the machine by means of a shaft, on which is a conical wheel, which fits into a circular rack attached to the lower frame. The blocks weighed 20 tons. The cradle is worked by chains on pulleys, as shown in fig. 3, and which are driven by the power shaft by means of conical teeth. The scaffolding was drawn by chains attached to bolts set into recesses in the crowns of the mole at every 30 m.

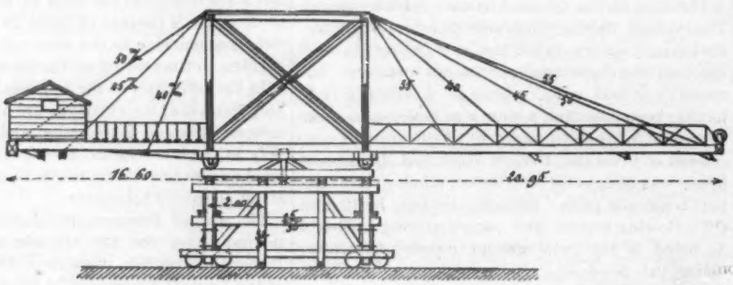


Fig. 1. — Elévation latérale.

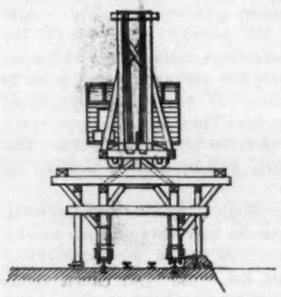


Fig. 2. — Elévation longitudinale.

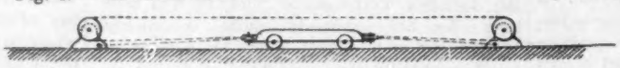


Fig. 3.

PERSONAL.

The DeLesseps Canal Company will call the second installment of 25 per cent. on 300,000,000 francs in January. Its medical corps has been reorganized, but the climate is none the less unhealthy.

The Order of Railway Conductors will hold its fourteenth annual convention in Buffalo, N. Y., Oct. 4. The Railroad Commissioners' Convention has been called to hold the fourth annual meeting in Atlanta, Ga., Oct. 11. The General Time Convention will meet in New York Oct. 13. The Southern Railway Time Convention will meet in New York Oct. 14.

Captain Belknap, commanding the United States steamer Alaska, reports from Callao the details of soundings in a run of 112 miles off shore. At a distance of 102 miles he found a depth of 3,368 fathoms, or nearly four statute miles, the deepest water yet found in the South Pacific, or in the deepest margins of both the North and South Pacific. He stood ten miles further to the eastward, but only found 3,168 fathoms. In both casts the cylinder brought up clay and greenish sand, and the bottom temperature of the deepest was 34.2 degrees Fahrenheit.

Mr. John Birkenbine, the Secretary of the United States Association of Charcoal Iron-Workers, informs us that a meeting of that society will be held in Cincinnati, on Oct. 7. The Exposition and various po ints will be visited, and there will be sessions for the election of officers and the reading of papers. On the 10th, a trip through the Hanging Rock region and other iron-making districts in Ohio, and probably also in Kentucky, will be begun and continued until the 13th or 14th, when the last sessions will be held at Ironton. The executive committee has extended a cordial invitation to all interested in the special field of the Association, which, though young, has now become a recognized power through the energy of its officers, among whom Mr. Birkenbine has been prominent in his efforts to organize the Association and carry it to its present creditable development. We may add that, following the example of the American Institute of Mining Engineers, the Charcoal Iron-Workers have appealed to the ladies to aid their meetings by their presence.

MICHIGAN ASSOCIATION OF SURVEYORS AND CIVIL ENGINEERS.

Lansing, Mich., Sept. 27.

Dear Sir: As required by standing resolution on page 7 of last report, the executive committee will meet about Nov. 1, to arrange for the coming annual meeting of the society. The committee desires to make a full and satisfactory programme, and hereby cordially invites every member of the society and of the profession to suggest topics for discussion or questions of practice for decision. In short, tell us what you want, and do so before Nov. 1. Address any member of the committee.

Applications for membership should be made at once.

Acts 73 and 103 of the Laws of 1881 are of interest to the profession. The laws are now to be found in most of the county offices.

By order of committee.

J. E. Sherman, Secretary.

AN APPEAL FOR AID.

On Sept. 17 I received a communication from the Register of Deeds of Huron County, stating that our Mr. Henry Strudwick had lost his property and instruments in the recent great fire, and asking if the surveyors of the State would not contribute to replace the latter. I asked for a definite statement, and received the following letter:

Huron County Register's Office,
Carl Heisterman, Register,
Bad Axe, Mich., Sept. 20, 1881.

Dear Sir: In reply to yours concerning Mr. Strudwick's affairs, I will state that he lost by fire a house and barn, crops, fences, etc. He saved with the greatest heroism a new house just commenced and only partly finished. He lost a theodolite and level by Hewitt & Son of New York, a Grumman patent steel chain and a collection of office instruments. All he saved was a leveling rod. The greatest trouble is that it is impossible for him to collect his fees. He had several jobs of surveying last summer in the towns of Bloomfield, Huron and Bingham, where almost every man lost his all. He has no means—I am certain of it—of replacing his lost instruments; has a wife and three small children, and the best recommendation I can give him is, he is a sober, frugal and very industrious man, and has no other way of supporting his family than by surveying, of which science he is master.

If you can do anything for him, please do it as soon as possible. Yours respectfully, Carl Heisterman.

I will gladly receive any contributions and account for the same to our executive committee, and I propose that the money be expended under its direction. Letters containing currency should be registered. Any one having good second-hand instruments for sale may send me description and price. J. E. Sherman, Secretary.

Approved: Chas. E. Greene, President.

[The above appeal for aid, which is not the only one which has reached Mr. Sherman, tells its own story, the wretched reality of which can be appreciated most fully by those of our readers who are familiar with the ordinary life and work of a land surveyor. The business at its best is but a hard struggle for the necessaries of life, and here

we realize that not only are the earnings of the past year swept away, but that a common calamity has also taken the means for earning in the future, if it were possible to find clients in such an impoverished community as the burnt districts of Michigan now possesses. The past few weeks has been a season of generous giving. Surveyors and engineers are not usually the favorites of fortune, but they also are not without a fair proportion of the "good things of this world," and especially so in the present year of grace and prosperity. We propose, therefore, that contributions in aid of such burnt-out Michigan surveyors or engineers as stand in need thereof be forwarded to Mr. J. E. Sherman, Secretary of the Michigan Association of Surveyors and Civil Engineers, who will acknowledge the same each week through the columns of this and any other journal he sees fit to communicate with, and to whom and Prof. Chas. E. Greene, of Michigan University, may be left the disposition of the funds. Sums from one dollar up will be most acceptable, and there is no doubt of the money being so judiciously expended that the recipients and the givers will be equally gratified. We hope there will be a speedy and liberal response.—Ed. Engineering News.]

THE HISTORY AND STATISTICS OF AMERICAN WATER-WORKS.*

BY J. JAMES R. CROES, M. AM. SOC. C. E.

(*Continued from page* 382.)

XCII.—BANGOR.

Bangor, Maine, in lat. 44° 47′ 50″ N., long. 68° 47′ W., is on the west bank of the Penobscot River, at its junction with the Kenduskeag River, about 55 miles from the ocean. Both rivers above the city are broken by falls for 12 miles, affording valuable water power. The French erected a fort at this point before 1656, and called it Norombega. The town was begun in 1769 and was called Kenduskeag at first. It was incorporated as a town in 1791 and as a city in 1834.

In 1875-6, the population being 12,000, water-works were built by the city, taking water from the Penobscot River.

The water-shed of the river has an area of 7,200 square miles, mostly covered with forest.

The water is impounded by a dam of crib and stone-work 900 ft. long, the inner slope backed with rip-rap, and the apron of hemlock plank having a slope of 3 to 4. In 1876 a filter gallery was constructed of brick, pebbles and sand.

Water power is used for pumping, turbine wheels driving a Holly piston pump and a rotary pump, each of 3 million gallons capacity in 24 hours. There is also a Holly steam pumping engine for reserve use. The pumps deliver directly into the distribution.

The distribution is by cast-iron pipe, the main being 16 in. in diameter.

In 1878 there were 23 miles of pipe in use, with 153 fire hydrants. The number of taps and the daily consumption have not been obtained. The population in 1880 was 16,857.

The works have cost about $500,000; the annual expenses are given approximately at $5,000, and the receipts $17,000.

The works are managed by the Bangor Water Board. L. H. Eaton, C. E., was chief engineer of construction. F. E. Sparke was superintendent in 1878.

XCIII.—CHESTER.

Chester, Pennsylvania, is in lat. 39° 52′ N., long. 75° 18′ W., on the Delaware River, 10 miles below Philadelphia; settled in 1643, it was originally called Upland.

In 1867, the population being about 10,000, water-works were built by the South Ward, one of the wards of the city, after plans of Isaac Cassin, C. E. Water is taken from the Delaware River, by a 12-in. cast-iron pipe, extending 400 ft. under the river, its outer end resting on a flat rock in 15 ft. of water at low tide.

Pumps geared to a 25 horse-power steam engine, built by C. A. Weidner, lift the water 106 ft. into the distributing reservoir, which has a capacity of 1,000,000 gallons.

The distribution is by cast-iron pipe of 4, 6, 8, 10 and 12-in. diameter, of which 12 miles were in use in 1878, with 57 fire hydrants and 1,100 taps.

The population in 1880 was 14,996. The consumption in 1875 was 406,000 gallons per day.

The original cost of the works was $79,000.

The receipts from all sources during 1875 were $26,000, and the expense of maintenance about $5,000.

The works were built by bonds issued on the real estate of the ward. The works are managed by a board of five councilmen of the ward. H. C. Eyre was the superintendent from 1868 to 1878.

XCIV.—ROME, N. Y.

Rome, New York, is in lat. 43° 11′ N., long. 75° 23′ W., on the Mohawk River, at the head of the Mohawk valley, on level ground, which in the early days of the settlement of the country was known as "the carrying ground," being the only interruption in continuous water communication between the Atlantic and the Lakes.

In 1872 water-works were built by the city, after the plans and under the superintendence of Peter Hogan, C. E., taking water from the Mohawk River, and pumping it by water power into a reservoir 330 ft. in diameter and 25 ft. deep, with a capacity of 9,000,000 gallons, at 60 ft. above the pumps. Distribution is by wrought-iron and cement pipes, of which 15 miles were in use in 1878, with 100 fire hydrants and 400 taps.

The population in 1880 was 12,045, and the daily consumption not known.

The cost of the works has been $165,000. The yearly cost of maintenance is about $3,000, and the receipts $9,000.

The works are managed by water commissioners, appointed by the city council. Charles T. Hayden was the superintendent in 1878.

XCV.—ROME, GA.

Rome, Georgia, is on the Coosa River, in the northwestern part of the State.

In 1871 water-works were built by the city, taking water from a well 12 ft. diameter and 5 ft. deep, from the bottom of which two tunnels 30 ft. long run north and south, acting as an underground storage reservoir.

The water is pumped by a beam engine with steam cylinder of 20-in. diameter and 42-in. stroke, and pump of 16-in. diameter and 42-in. stroke, with a capacity of 700,000 gallons in 24 hours, into the distributing reservoir, which is of wrought iron, 25 ft. diameter, and 63 ft. high, placed on a hill in the centre of the city. Its flow line is 200 ft. above the water in the well.

The distribution is by cast-iron pipe. In 1878, 5 miles had been laid, with 55 hydrants; five meters were then in use.

The daily consumption in 1876 was 700,000 gallons.

The population in 1880 was 4,374.

The cost of maintenance for 1875 was $2,663.70, including extensions of pipe.

The works are managed by the common council. Junius George was engineer of the water-works in 1875.

XCVI.—OGDENSBURGH.

Ogdensburgh, New York, is in lat. 44° 42′ N., long. 75° 29′ W.; is on the St. Lawrence at the mouth of the Oswegatchie River, 72 miles below Lake Ontario. Founded in 1749, it was incorporated as a village in 1817, and as a city in 1868.

In 1868 water-works were built by the city, after the plans and under the superintendence of G. W. Pearsons, C. E., taking water from the Oswegatchie River, and pumping directly into the mains by Holly pumps, driven by water power, with an auxiliary steam-engine.

There is also a Flanders piston pump. Distribution is by wrought-iron and cement pipe. In 1878 14 miles had been laid, with 78 fire hydrants and 800 taps.

In 1876 the daily consumption was 800,000 gallons. The population in 1880 was 10,340. The works cost to 1876, $150,000, and the yearly cost of maintenance was $2,500.

The works are managed by the city. A. H. Lord is the superintendent.

XCVII.—BIRMINGHAM, CONN.

Birmingham, Connecticut, is in lat. 41° 19′, long. 73° 8′, at the junction of the Housatonic and Naugatuck, 9 miles west of New Haven.

In 1860 water-works were built by a private company, taking water from two reservoirs, one of 9 acres and the other of 30 acres area. They were formerly swamps and were ponded after some of the vegetable matter had been removed. The conduit is an 8-in. cement and wrought-iron pipe.

Distribution was originally by wrought-iron and cement pipes, which were afterward replaced by cast-iron.

In 1878 5 miles had been laid, with 47 hydrants, for which the city paid $30 each per year.

The number of consumers in 1876 was 300.

The population in 1876 was 3,500. In 1880 it was 7,000.

The cost to 1876 was about $60,000, and the yearly cost of maintenance $2,500.

The works are owned and managed by the Birmingham Water Company. Charles H. Nettleton was the superintendent in 1878.

XCVIII.—BIRMINGHAM, ALA.

Birmingham, Alabama, in Jefferson County, is of recent growth, at the intersection of lines of railroad.

In 1872-3, the population being 2,000, water-works were built by the Elyton Land Company after plans and under superintendence of Travers Daniel, C. E.

Water is taken from Village Creek, the area of whose water-shed is from 30 to 40 sq. miles, mostly of limestone formation. Its daily discharge at low water is about 35,000 gallons.

Water is taken from the creek, and pumped into the distributing reservoir by a Worthington duplex pump, with cylinders of 18-in. diameter and water-plungers of 12-in. diameter. Its capacity is 750,000 gallons per day; the lift is 175 ft.

The distributing reservoir is in excavation and embankment, lined with brick in cement, and has rounded corners. It is 58 by 113 ft. on the bottom, and 95½ by 150½ ft. at the top, with a depth of 12½ ft. The slopes are 1½ to 1. Its capacity is 1,000,000 gallons. It has leaked quite badly from time to time.

The distribution is by cast-iron pipes. In 1878 there were 6.50 miles, of which 3.2 miles were of less than 6-in. diameter, the largest being 8-in., with 15 fire hydrants, for which the city paid $66.66 each per annum.

The number of taps in 1876 was 200.

In 1880 the population was 4,050, and the daily average consumption 100,000 gallons.

The works cost to 1876 $66,500, and the yearly cost of maintenance was about $1,200.

The works are managed by the Elyton Land Company, of which W. J. Milner is secretary and superintendent.

XCIX.—BEAVER FALLS.

Beaver Falls, Pennsylvania, is on the Beaver

*Copyright 1881.

River, 4 miles from its junction with the Ohio, and 31 miles from Pittsburgh.

In 1875, the population being about 3,000, water-works were built by a private company, after plans and under superintendence of John Reeves, C. E., taking water from the Beaver River.

Water is filtered through the bank into a well, whence it is pumped directly into the mains by pumps of the Holly pattern driven by water power; the lift is about 175 ft.

Distribution is by cast-iron pipes. In 1878 6 miles had been laid, with 32 fire hydrants.

The population in 1880 was 4,327, and the daily average consumption 30,000 gallons.

The works cost to 1876 $30,000, and the yearly cost of maintenance was $1,000.

The works are managed by the Beaver Falls Water Company. W. H. Chandley was superintendent in 1878.

C.—POTSDAM.

Potsdam, New York, is in lat. 44° 40' N., long. 75° W., on the Racket River, which affords a fine water power. There are here extensive quarries of sandstone of the geological formation which has taken its name from the town.

In 1871 water-works were built by the village, after the plans and under the superintendence of Galen W. Pearsons, C. E., taking water from the Racket River, with a water-shed in the Adirondack Mountains of 30 sq. miles.

The pumps are of the Holly pattern, pumping directly into the mains under a domestic pressure of 35 lbs.

Distribution is by wrought-iron and cement pipe, of which in 1878 4¼ miles were in use, with 35 fire hydrants and 140 taps.

The population in 1880 was 3,500.

The works to 1877 had cost $50,000, and the yearly cost of maintenance was $550.

The works are managed by the village board of trustees. In 1878 A. N. Tupper was the superintendent.

CI.—BEDFORD.

Bedford, Pennsylvania, 200 miles west of Philadelphia, in lat. 40° 1' N., long. 78° 34' W., is on the Raystown branch of the Juniata River, on high ground and between two ridges, one of which rises about 1,200 ft. above the valley.

In 1872–6, the population being 2,000, works were built by the town. Water is taken from springs on the hill-side, and conveyed by 4-in. iron pipes to two reservoirs, whence is it distributed by gravity.

The flow line of the reservoirs is 120 ft. above the town. They are in excavation and embankment puddled with clay and lined with brick on edge laid dry.

The main from the reservoirs is of 4-in. cast iron.

The length of pipes and number of hydrants and taps are not given.

The population in 1880 was 2,564, and the daily consumption 30,000 gallons.

The works cost $34,000.

The cost of maintenance is about $275 per year.

CII.—BELLAIRE.

Bellaire, Ohio, is on the Ohio River, 5 miles south of Wheeling, W. Va.

In 1872 water-works were built by the town after the plans and under the superintendence of Joseph L. Lowrey, C. E., taking water from the Ohio River, and lifting it 216 ft. to the distributing reservoir by four pumps of 4-ft. stroke and 12-in. diameter. Originally there were two steam cylinders of 16-in. diameter, and 78-in. stroke.

These, not working effectively, were replaced by one steam cylinder of 18-in. diameter and 24-in stroke, geared to the pumps in both cases.

The distributing reservoir is semi-circular, 95 by 190 ft. with puddled banks and a 4-in. brick lining. The reservoir is a mile from the pumps, and is 165 ft. above the main part of the city.

Distribution is by the "Wyckoff" wooden pipe, with some cast-iron pipe. In 1878 there were 6¾ miles of pipe, from 12-in. to 3-in. diameter, with 76 fire hydrants.

The population in 1880 was 8,000.

The works to 1877 had cost $112,000, and the yearly cost of maintenance was from $4,000 to $6,000.

The works are managed by a board of trustees. H. G. Wilson was the superintendent in 1878.

CIII.—PLEASANT HILL.

Pleasant Hill, Kentucky, is a village of Mercer County, in the blue-grass region, near the centre of the State.

In 1833 water-works were built by the "United Society of Shakers" near Pleasant Hill, taking water from a spring, the discharge of which is 5,500 gallons per day.

Water is pumped by an old-fashioned force pump, with 5-in. discharge, worked by two horses, pumping with 120-ft. lift to a wooden tank reservoir, with capacity of 4,482 gallons.

Distribution is by cast-iron pipe.

In 1878 there were but 20 houses in the village, and a population of 300.

The annual cost of maintenance is $1,000.

C. A. Tasker is manager.

CORRESPONDENCE.

ENGINEER STUDENTS.

AMES, Ia., Sept. 26.

EDITOR ENGINEERING NEWS:

The following note may do for General Intelligence: The Senior Civil Engineers at the Iowa Agricultural College, Ames, Iowa, have finished a Howe truss bridge on the college grounds, they doing all the work from sharpening the piles to painting the bridge when finished. These young engineers will graduate from the four-years course of the college in November, and expect to follow the profession in solving whose problems they have spent so much time.

Yours truly,

C. F. MOUNT, C. E.

LACHINE CANAL, CANADA.

The boat canal was opened in 1700 by the Sulpicians, via River St. Pierre to Montreal; depth of water, 2½ ft.

The barge canal was commenced in 1821, and completed in 1825, at a cost of $438,404; length, 8¼ miles; lockage, 44½ ft.; bottom width, 28 ft.; at water surface, 48 ft.; 7 locks 100 feet long, 20 ft. wide, with 4½ ft. depth of water on sills.

The ship canal was commenced in 1843 and completed in 1849 at a cost of $2,149,128; length, 8½ miles; lockage, 44¾ ft.; bottom width, 80 ft.; at water surface, 120 ft.; 5 locks 200 ft. long, 45 ft. wide, with 9 feet depth of water on sills.

The enlarged ship canal was commenced in 1875; it cost $6,500,000; length, 8¾ miles; lockage, 45 ft.; summit level, Lachine to Cote St. Paul, 5¾ miles long; mean width, 150 ft. Reaches downwards to Montreal 3 miles; mean width, 200 ft.; intended depth, 15 ft.; 5 locks, 270 ft. long, 45 ft. wide, three of which have 14 ft. depth of water on the sills, and two at the lower entrance, together with adjoining basins, between Grand Trunk Railway at Point St. Charles and harbor of Montreal, are adapted to vessels of 18 ft. draught. Five swing bridges on piers of cut stone, having an opening 46 ft. wide on each side of center, for passage of vessels, and a waterway 32 ft. wide on both sides of canal.

Lock walls throughout, also the basin and dock-walls for one mile above lower terminus, are of cut stone laid in hydraulic cement mortar. Thence upwards for half a mile, the dockwalls are of random-coursed masonry laid in cement mortar. Between the third and fourth locks, a distance of 1½ miles, the side walls are of random-coursed stone laid at right angles to a face inclination of two-thirds to one. Summit level, for 4½ miles faced on both sides with masonry laid dry.

Entrance on Lake St. Louis formed on cribwork on which is to be built a superstructure of masonry.

From the Atlantic entrance of the Straits of Belle Isle, via the River St. Lawrence and inland lakes to Fond du Lac, at the head of Lake Superior, the distance is 2,384 miles. On this route there are the Lachine, Beauharnois, Cornwall, Farran's Point, Rapide Plat, Galops and Welland canals, the aggregate length of which is 70¾ miles, and the total lockage 536½ feet, through 54 locks, up to Lake Erie; also the Sault Ste. Marie Canal, built by the United States, 1¼ miles in length with 18 feet of lockage, uniting Lake Huron and Lake Superior.

Lake Superior is about 600 feet above the highest tides of the River St. Lawrence at Three Rivers, 86 miles below Montreal.

THE SOURCE OF THE MISSISSIPPI.

For years Lake Itaska has been regarded, both by geographical societies and map-makers, as well as by the public generally, as the source of the grandest of rivers—the mighty Mississippi. But geographical knowledge, like other knowledge, is nothing if it is not progressive, and in its history we have seen the firmly-rooted beliefs of centuries torn up and tossed aside by the explorations and reasoning of intrepid travelers, who, respecting truth and facts more than mere theory, have accepted nothing without proof merely because others have so accepted it. This is the ground occupied by Captain Willard Glazier in his explorations in search of the source of the Mississippi.

Starting for the headwaters of this great river in July last, he learned that the dense forests which surrounded the source of the Father of Waters were rarely penetrated by white men, or even Indians, at any time except in winter, when lakes and rivers were frozen up, and the whole surface of the country covered with a mantle of snow.

He also heard, through the Indian guides and interpreters who accompanied him, that the aboriginal inhabitants of these primeval forests did not regard Itaska as the source; but while rejecting it, differed among themselves as to what lake really was the fountain head. Some claimed that the stream from Itaska was not itself the main stream, but flowed into the river proper some three miles below the lake. The stream to which it was tributary, though narrower, was, they claimed, deeper and swifter, bringing to united streams more water than the one from Lake Itaska.

Others considered the Itaska stream as the main one, but talked of another lake, broad and beautiful, which lay above Itaska and poured its clear waters into the accepted source through a small stream which entered the southern arm of Lake Itaska. Captain Glazier determined to thoroughly examine all this region and to settle definitely and forever the true source of the Father of Waters.

Acting in accordance with this design the Captain pushed on toward Itaska, intending to make it a starting point for further explorations. Reaching this objective point, after innumerable hardships, he camped on Schoolcraft's Island, and after a day of rest he directed operations toward the lakes and streams of the surrounding country.

Thoroughly surveying the stream that the Indians claimed to be the main one, he found it much inferior in volume to that from Itaska. This point settled, he closely examined the shores of Lake Itaska for tributary streams, finding but three of any importance. Of these three the one by far the largest came in at the extreme head of the lake, at a point where it is nearly filled with bullrushes.

Taking two canoes Captain Glazier ascended this stream, which though shallow is rapid, yet so narrow in places that to jump across it would be an easy task. Following its windings for about three-quarters of a mile, he entered what appeared to be a little lake filled with rushes. Pushing through this, however, the canoes glided out upon the still surface of a magnificent lake, clear as crystal, with a pebbly bottom, and shores covered with a thick growth of pine. The lake is formed irregularly in the shape of a heart, having but one marked promontory. Its greatest length is about two miles, and its width a mile and a half.

Captain Glazier found that this lake was supplied by three little rivulets, which rose in swamps a few miles from the lake, and thoroughly convinced that this beautiful lake was the true source of the mighty Mississippi he proclaimed it as such. Without waiting for discussion the members of the party decided unanimously and by acclamation to call it Lake Glazier in his honor. Modestly expressing his thanks for this mark of their appreciation, Captain Glazier said that, though he firmly believed this lake to be the source of the river he should relax none of his vigilance on the

trip through the unknown part of the stream, but would carefully examine all streams flowing into the Mississippi in order to be positive that it was really the main stream. It is needless to add that no larger stream was found.—*St. Louis Globe-Democrat.*

WIND PRESSURE UPON BRIDGES.*

It may be safely stated that the practice among American engineers is very nearly uniform in regard to wind strains. My own specifications, which I have used in constructing a number of exceptionally high bridges, some of them in especially exposed positions, are as follows:

"The portal, vertical and horizontal bracing shall be proportioned for a wind pressure of 30 lbs. per square foot on the surface of a train averaging 10 sq. ft. per lineal foot, and on twice the vertical surface of one truss. The 300 lbs. pressure per lineal foot due to the train surface shall be treated as a moving load, and the pressure on the trusses as a fixed load. Trusses of less than 200 ft. span shall also be proportioned for a pressure of 50 lbs. per square foot when unloaded, and the greatest strain by either method of computation shall in each case be used in determining the sectional areas of the bracing.

"Iron piers and spans carried by them shall be designed to resist a wind force of 30 lbs. per square foot on train and structure, or 50 lbs. per square foot on the structure alone. The compressive strains on the leeward columns of the piers shall be computed with the assumption that the maximum load is on the bridge, and to these shall be added the compressive strains produced by the wind, and the columns shall be proportioned to resist these combined strains with a factor of safety of four. The minus strains on the windward columns shall be computed with the lightest train on the bridge which will not be blown off by a wind force of 30 lbs. per square foot, and such a width of base shall be given to the pier that there shall be no tension in any of the columns composing it.

"If the bridge if on a curve, the centrifugal force due to the maximum load moving at forty miles per hour shall be added to the strains arising from wind pressure on span and pier. To resist the strains computed as above specified, tensile bracing shall be proportioned at 15,000 lbs. per square inch; the shearing sections of pins, bolts and rivets, at 10,000 lbs. per square inch; rivets in tension at 5,000 lbs. per inch; bending stress of pins at 22,500 lbs. per square inch, and struts in compression with a factor of safety of four. The end connections of all wind bracing shall be stronger than the bracing itself. Joints of pier columns shall be fully spliced, so that not less than one-half of the sectional area of the column is available for a tensile strain. In case the sectional area of a pier column proportioned for the load, wind and centifrugal strains combined, with a factor of four, is less than the section required for load and centrifugal strains only, at the specified factor for load stress, the largest section shall be used in all cases.

"To all strains computed as above for wind bracing there shall be added an initial stress of 10,000 lbs. in each member, in order to allow for the strains produced in screwing up the rods during the adjustment of the bracing."

Two features in the foregoing require explanation;

First.—Relating to the area of exposed surface, my experiments on the Rock Island pivot span in 1872 showed that the resistance to wind by the structure was that due to rather more than $1\frac{8}{10}$ times the exposed surface of one truss.

Last.—The wind pressure on the train is treated as a rolling load, because the action of lateral shear on wind bracing is precisely the same as that of vertical shear on the web members, *i. e.*, greatest with partial loads.

The following railways and bridge companies use practically the same specifications as the foregoing:

Chicago, Milwaukee & St. Paul Railway; Cincinnati Southern Railway; Keystone Bridge Company, of Pittsburgh; St. Louis, Kansas City & Northern Railway; Denver & Rio Grande Railway; Atchison Topeka & Santa Fé Railway; St. Paul Minneapolis & Manitoba Railway; Gulf, Colorado, & Santa Fé Railway.

Many engineers prefer to express wind force in pounds per lineal foot of bridge, instead of per square foot of exposed surface. Using a 200-ft. span as an example, the specifications in question can be condensed as follows:

Fixed load in plane of roadway, 210 lbs. per lineal foot.

Fixed load in plane of other chord, 130 lbs. per lineal foot.

Moving load in plane of roadway, 300 lbs. per lineal foot.

Iron in tension, 15,000 lbs. per inch.

Iron in compression, factor, 4.

The Erie Railway specifications are as follows:

Fixed load, roadway chord, 150 lbs. per lineal foot.

Fixed load, other chord, 150 lbs. per lineal foot.

Moving load, roadway chord, 300 lbs. per lineal foot.

Iron in tension at 15,000 lbs.

Iron in compression, factor 4.

The Greenville & Columbia Railway specifications are the same as the Erie, except that 200 lbs. per foot are used for the top chord of through bridges.

The Louisville & Nashville specifications are the same as Erie, but no moving load is used—simply 450 lbs. per foot on roadway bracing and 150 lbs. per foot on the other chord.

The Lake Shore road uses 300 lbs. per foot fixed load on roadway laterals and 150 lbs. on the other chord, but strains in tension are 10,000 lbs. per square inch only.

The Chicago, Rock Island & Pacific Railway prescribes 300 lbs. per foot, with iron at 10,000 lbs. per inch.

The Pittsburgh, Cincinnati & St. Louis Railway requires 300 lbs. per foot for the train and 30 lbs. per sq. ft. on one truss only.

The Louisville Bridge Company uses the same specifications as the Louisville & Nashville Railway.

For the bridge over the Missouri, at Glasgow, 50 lbs. per square foot on one truss and 300 lbs. per foot for train were used.

For the Eads bridge, at St. Louis, 50 lbs. per square foot on the structure alone was the specified pressure.

For the Kentucky River bridge the wind pressure was assumed at $31\frac{1}{2}$ lbs. per square foot on spans, train and piers, and factor four was used in proportioning the bracing.

The Portage bridge, in New York, was built to resist 30 lbs. per square foot on structure and train, and 50 lbs. per square foot on the structure alone.

Both of these last bridges are unusually lofty and in exposed positions, and both are on iron skeleton piers.

The 520-ft. span over the Ohio, at Cincinnati, was designed to withstand 50 lbs. per square foot on structure alone, or 30 lbs. per foot on train and structure combined.

Thirty pounds per square foot was recommended by the majority of the members of the Committee on the "Means of Averting Bridge Accidents," in their report to the American Society of Civil Engineers in March, 1875. One of that Committee, however—General Ellis—advised 40 lbs. per square foot, which specification is also used by Mr. Slataper, Chief Engineer of the Pennsylvania Railway Company.

Having given the foregoing examples as a fair average of the current practice of American engineers in regard to wind pressure, I will add the data on which I base the opinion that the specifications first recited fulfill all the requirements of the case, even in what is known as the tornado belt of our Western States.

For a number of years past, whenever practicable, I have personally visited the tracks of destructive storms as soon as possible after their occurrence, for the purpose of determining the maximum force and width of the path in each case.

The most violent on my records are as follows:

First.—East St. Louis, 1871: Locomotive overturned; maximum force required, 93 lbs. per square foot.

Second.—St. Charles, 1877: Jail destroyed; force required, 84.3 lbs. per square foot.

Third.—Marshfield, Mo., 1880: Brick mansion house leveled; force required, 58 lbs. per square foot.

Fourth.—Havre de Grace, Md., 1866: Ten spans wooden Howe truss bridge, 250 ft. each, blown over; force required, 97 lbs. per square foot.

Fifth.—Decatur, Ala., 1870: Two spans of combination triangular truss blown over; force required, 26 lbs. per square foot.

Sixth.—Meredosia, Ill., 1880: One span wooden Howe truss, 150 ft. long, overturned; force, 24 lbs. per foot.

Seventh.—Omaha, Neb., 1877: Two spans iron post truss, 250 ft. each, blown down; force required, 18.7 lbs. per square foot.

Also, sundry cases of train derailment caused by wind, the maximum force required being 30.5 lbs. per square foot.

In each of the foregoing cases I have given what appeared to be the maximum effort of the wind, and the lowest pressure required to produce the observed result. It is, therefore, not unlikely that the real force of the wind in each example was greater than I have stated it. Some of the tornadoes were very destructive, the Marshfield one, for instance, having cut a swath 46 miles long and 1,800 ft. wide and killed and wounded over 250 people. To the above cited instances may be added the Tay Bridge disaster, in which case $20\frac{4}{10}$ lbs. per square foot on train and bridge were required to destroy the piers, through the rupture of the vertical bracing in the four bottom tiers of the pier over which the train was passing when failure began. My reasons for considering 30 lbs. per square foot sufficient for a working specification, when the above record shows much higher pressures, are these:

First.—I very much doubt if a *direct* wind or gale ever exceeds 30 lbs. per foot; whirlwinds do exceed it, but the width of the pathway of maximum effort in these is usually very narrow, although the general direction is so erratic that the appearance of the débris is generally such as to produce the impression that the vortex was much larger than was really the case. With the exception of the Marshfield tornado, I have yet to find a storm swath where the width of pathway wherein the force exceeded 30 lbs. per square foot, was more than 60 ft. wide.

The St. Charles tornado is a case in point. This whirlwind cut a swath about 1,000 ft. wide for 14 miles and destroyed over 300 houses, exerting a force of over 84 lbs. per square foot at its point of maximum effort. It crossed the middle span of the St. Charles bridge nearly at right angles, and developed a pressure of $52\frac{1}{10}$ lbs. per square foot in picking up and crushing a barrel of tar, which stood on the bridge in the path of the vortex. The width of the vortex was distinctly marked on the span by the circle in which the tar was spun around, the wreckage left upon it, and the points at which it ceased to destroy the flooring. This width was thus shown to be slightly over 60 ft. and, guided by this, I was subsequently enabled to locate the path traveled by the central vortex throughout the entire length of the storm swath. The bridge itself was uninjured, although it was only proportioned to withstand 30 lbs. per square foot, with a strain of 20,000 lbs. per square inch on the braces. This span was 320 ft. long, 30 ft. in depth, and the top chord was 120 ft. above the water. I consider it very unlikely that a bridge of over 200 ft. span will ever be exposed to a wind force of more than 30 lbs. per square foot, acting *in the same direction* over its entire length.

Next.—A fully loaded passenger train, and the heaviest possible freight train, will leave the track at the respective pressures of $31\frac{1}{4}$ and $56\frac{1}{4}$ lbs. per square foot. If the braces are proportioned at 15,000 lbs. per square inch, with a wind pressure of 30 lbs. per square foot, they will still be within their limit of elasticity at the moment when the train is blown from the track in either case. Destruction of the span will then take place, if at all, from the effects of derailment; to resist which greater strength in the wind bracing will be of no value.

Next.—If there is no tension in the pier columns until 30 lbs. wind pressure is reached, and these columns are properly spliced and anchored, as per specifications, there will be an ample margin of tensile strength in any case where this pressure may be exceeded.

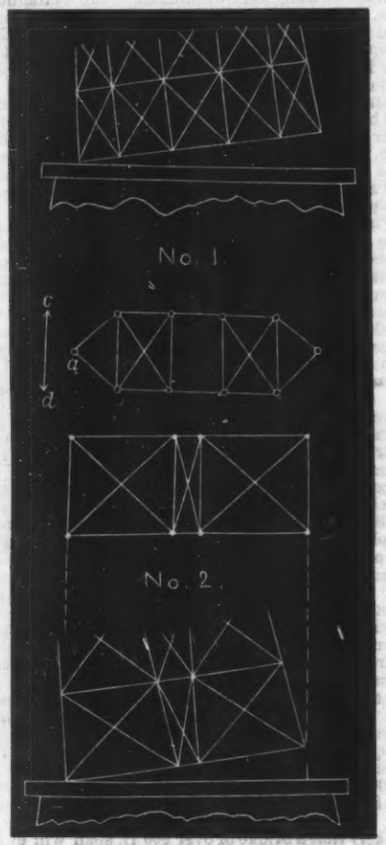
Last.—In view of the comparative rarity of these extreme strains, the consequent slight fatigue to which the iron is exposed, the high stresses imposed on the wind bracing are perfectly legitimate.

It will be noted that the specification as to width of base being such as to eliminate all tensile strains in the pier columns at the specified wind pressure, marks a characteristic difference between European and American practice. The French, Swiss and Austrian viaducts are all exposed to tension in the piers at comparatively low wind pressures, and, although these strains are provided for in the design of each structure, this provison includes

* Paper presented by C. Shaler Smith before the American Society of Civil Engineers, Dec. 15, 1880.

[NOTE.—The substance of this paper was embodied in a letter written in response to a request from the Secretary of the American Society of Civil Engineers. The occasion of this request was to obtain a statement of the practice of American engineers in regard to wind strains, and to secure this the Secretary corresponded with a number of the members of the Society who had large experience in the construction of bridges. Extracts from the letters of these members were transmitted to Sir John Hawkshaw, Hon. Mem. A. S. C. E., who had asked the Secretary to obtain this information for the use of a commission upon the subject in England. With the consent of Mr. C. Shaler Smith, the substance of his letter is issued as this paper.—EDITOR.]

subjecting cast iron to tension, something not permissible in American practice, although our best cast iron is much superior to that of Europe. Indeed, I am not aware of any skeleton bridge piers in this country which have been built within the last ten years having cast-iron pier columns. Another radical difference is to be found in the structural design of viaduct piers, which in Europe are generally composed of from six to fourteen columns, including two columns as wind braces, one at each end of the pier, while in America the material is concentrated in four or eight columns; the wind braces and load-carrying columns being the same. As the internal bracing is or should be strong enough to enable the piers to turn over without collapsing the great weakness of any pier, which must rotate on a single point, is readily seen from the following sketches:



Sketch No. 1 shows the ordinary European ground plan of a skeleton pier, and the position which the pier must assume, if the internal bracing is strong enough to hold the pier together until the overt urning pressure is reached. It will be seen at once that collapsing must result from the impossibility of maintaining column "*a*" in the direction of "*c d*."

Sketch No. 2 shows an American pier of the usual type, and the fact that collapsing can be easily guarded against becomes apparent on inspection. It is also evident that unless collapsing is prevented, the full value of the anchorage bolts cannot be obtained. In my enumeration of various railway specifications, I have given one from each representative district of the country, excepting New England, and the structures mentioned are, with one exception, located in what is called the "tornado area" of the Western States.

The following account of the St. Charles tornado was written for the *Cosmos*, a local journal of date of March 1, 1876, by a personal observer, Mr. C. C. Davis, and is published as giving, in the opinion of Mr. C. Shaler Smith, an accurate description of the commencement of the whirl:

At half past one o'clock, on last Saturday afternoon, a heavy storm cloud was observed directly south of the city, moving slowly due north. A few minutes later a similar cloud, but at a greater elevation, and with a much more rapid motion, appeared on the horizon, a few degrees south of west, its course being nearly east. The surface wind at first was light, and from the southeast. The clouds soon lapped. Discharges of electricity from the lower to the upper cloud became frequent, but not heavy, and with their junction the entire mass rapidly settled toward the earth. Patches of flying scud appeared moving in every direction, and small showers of rain or hail could be seen falling at various points. The storm nimbus, by this time, had covered all the upper part of the city, its normal cloud-tint being here and there flecked with dissolving spots of an unearthly green. Soon came signs of fury which was to follow. The wind came in light, fitful gusts from every direction, succeeded by intervals of dead calm, the ominous stillness of the latter being especially marked. After a few short, sharp dashes of hail, interspersed with rain, a most singular phenomenon occurred; a genuine shower of snow-balls, some of which, as they lay on the ground, could hardly be covered by a teacup. These were immense hail-stones, generated in the cold upper cloud, and softened in passing through the warm and water-laden cloud from the south. So large were they that their white shapes were seen several hundred feet in the air, their color placing them in bold relief against the murky, sullen blackness of their parent cloud. A few moments of oppressive silence followed, when suddenly the rival storm-fiends leaped into infernal life, the ragged wind-scud flew in all directions, and almost instantly the lurid brown of a cyclone column appeared in the southwest, about three miles from the upper end of the city. Moving eastward at first, until the river slopes had been reached, the terrible cloud-column followed them to the city, giving dreadful presage of its coming in a deep-toned, humming roar, very similar in sound and disagreeable effect to the noise and earth-shaking properties of the steam-blower of a locomotive-engine, but magnified a hundred-fold. In appearance it was the true cyclone cloud—a brown, murky, vertical column, largest at its junction with the parent clouds—never more than 400 ft. in diameter—reaching sometimes to the earth, where it destroyed all that it touched; and occasionally receding upwards and passing harmlessly over those intervening spaces, where its powers were expended in the air above the buildings. Deliberately, but erratically, it moved through our devoted city—death in its roar, and destruction in its touch. The central vortex reached the spire of the German Methodist Church—a twist, a crash, and the spire went spinning upwards, but preserving its vertical position until near the top of its flight, when it was suddenly reversed, and came down point foremost. This vortex also touched the jail, the roof of which, together with the whole upper story, was twisted off—and to this hour the roof has not been found.

From this point the scene beggars all description. The total destruction of everything grasped by the tornado can be compared only to the wide-spread ruin produced by the explosion of a powder magazine. The streets were filled with heavy timbers reduced to the merest splinters. Walls, where not laid flat, were in many cases punctured with holes by flying joists and bricks, projected with a force not much less than if shot from a cannon. Near the vortex, houses were destroyed by twisting and bursting; persons inside found it impossible to open the doors to get out, owing to the external vacuum and the pressure from within. On the circumference of the cyclone houses were crushed and overturned by the external force, and those living in this part of its track had doors and windows blown in from without, as a preliminary to the destruction of the building.

After crossing the railroad track, the column became less in diameter, followed a very devious route, and moved so slowly that one observer, who had seen it pass when he was near Morgan street, succeeded in repassing it while it was destroying the houses between Second street and the river, in Frenchtown, and reached the bridge some time before the tornado had finished its work of destruction on the west side of Second street.

After having followed the main streets of the city to within 300 ft. of the bridge, the cyclone turned suddenly eastward, moved parallel to the bridge and then crossed it at the middle of span four. It was an anxious moment to the three bridge men who were watching it. The whirlwind had destroyed everything it had touched thus far, and the deadly column was black with timber and other *débris* of the houses it had wrecked, while high above the rest sailed a large roof, moving with terrific speed toward the bridge, which it was now clear would be crossed by the very vortex of the storm. For a second the cloud obscured the span, the flying roof soaring 50 ft. above it, but in another instant the grand old bridge loomed out clear and sharp—its outlines all unbroken against the black background of the defeated Storm-King, who swept muttering away.

From the bridge the column crossed to the St. Louis shore of the river, destroyed a number of large trees on that side and then turned again and crossed to the west side again, raising the water nearly 200 ft. high in its path, and reaching the St. Charles shore some two miles below the bridge. From this point it ceased to be a St. Charles institution, and we must rely on our country correspondents to tell us of its doings beyond our immediate ken.

At 15 minutes past two the storm was over, and half an hour later the sun was shining, and the uncomfortable warmth of the morning had given place to a cold and chilly atmosphere and western wind, which followed in the track of the higher and colder cloud, and which, in this battle of the elements, had proved victorious.

From the circular motion of the wind, it is difficult to measure its exact force, although there are several definite points where we are enabled to fix positively that the pressure exceeded a certain limit. One of these is the water tank at the jail. This stood fairly where the wind could act both on the sides and bottom. With the water in it at the time, we are told that 69$\frac{4}{10}$ lbs. per square foot upward and lateral force was required to overturn it, and it *was* overturned.

Another point fixed is the overturning force required to carry off a barrel half full of coal-tar which stood on the bridge, and which was blown over and away. This needed 71$\frac{5}{10}$ lbs. pressure to overturn it. The significance of these figures will be understood, when we state that a wind, with a speed of 80 miles per hour—giving a pressure of 31$\frac{1}{2}$ lbs. per square foot, is defined by the authorities as a "violent tornado." We are perfectly satisfied with our experience in cyclones, and want no more of them.

DISCUSSIONS ON THE PAPER UPON WIND PRESSURE UPON BRIDGES.

Charles Douglas Fox, of London, Corresponding Member A. S. C. E.—Mr. C. Shaler Smith's paper is to me very interesting as being the first instance I have seen of an attempt to formulate distinct rules upon this subject. It is understood that the French engineers adopt a maximum wind pressure of 55 lbs., but in Great Britain the matter has been hitherto left to the discretion of the individual engineers, the Board of Trade requirements for railways making no mention of the point.

It is but comparatively rarely in English practice that bridges occur of such span and height as to render necessary any separate consideration of the wind pressure upon either girders or piers, the strength and stability necessary to resist the effects of trains running at high speed, with a factor of safety of 4, being, in ordinary cases, such as to provide a large margin far safety against the effects of wind. A perusal of the evidence given before the commissioners appointed to report upon the accident to the Tay Bridge will show that engineers and scientists also widely differ as to the pressures to be expected, both as to their force and their extent, ranging upon the structure in question, having spans of 245 ft., and a height of 115 ft., from 15 lbs. up to 50 lbs. per foot. The Astronomer Royal of England stated, in his evidence, his opinion, that while a force of 40 or 50 lbs. per superficial foot might be experienced upon limited areas, say up to 250 ft. in width, the maximum average force upon a larger area of say 1,600 ft. in width would, probably, not exceed 10 lbs. per superficial foot, but this would, from Mr. Smith's paper, appear to be contrary to experience in the United States at least. It was further stated by engineering witnesses that, leaving out of consideration the strength of the bolts which secured the cast-iron columns to the piers, it would have required a force of from 33 to 34$\frac{1}{2}$ lbs. per foot, or, taking the bolts into account, then from 60 to 70 lbs. per foot upon the piers, girders and a train of carriages, to overturn the bridge, if no failure took place in the details of construction. At the time of this inquiry, in the spring of 1880, no reliable measurements of pressure up to 50 lbs. per foot had been made at the Royal Observatory, but I understand that, in the terrific easterly gale of Jan. 18 last, the anemometer, on three occasions, registered this amount of pressure. As, however, the instrument is placed on the observatory building, it is possible that it may be subjected to eddies, which would cause it to register more than the normal pressure.

My practice, which I believe accords with that of many engineers in this country, has been, in

dealing with roofs, to assume a maximum pressure per superficial foot of 40 lbs.; of which 30 lbs. are taken for the resultant pressure of the wind, at right angles to the roof, and 10 lbs. for snow, it being very rare for much snow to lie upon such structures when there is a heavy wind. For India, where such structures are exposed to severe cyclones, the same maximum pressure of 40 lbs. is taken: in this case wholly for the wind, snow being unknown. The maximum strain upon the wrought iron of the roofs under such pressure would be about 16,000 lbs. per sectional inch, giving a factor of safety of at least three. Roofs thus proportioned have been lately exposed, without injury, to one of the heaviest cyclones ever known in South India, a storm which tore up trees by the root and caused very serious damage to buildings of various kinds.

ROBERT E. JOHNSTON, of Liverpool, M. I. C. E.—The question of wind pressure does not appear to have received the amount of attention from British engineers that the importance of the subject demands; this, no doubt, is due in a great measure to the fact that the wind in this country does not attain to anything like the force it does in America, but the destruction of the Tay Bridge has given a prominence to the subject it never had before, and has proved that even in this country the effects of the wind cannot, with impunity, be neglected. The extent of our information of a reliable character with regard to the pressure of the wind, and the force it exerts against the complicated forms which the varied structures erected by engineers assume, is of a very limited nature, and it is desirable to determine by actual observation the pressure exerted by the wind at various velocities on flat, inclined, hollow and round surfaces. Investigation should also be made as to the action of the wind on close latticing, and the reduction that takes place in the pressure on the rear surface when two flat surfaces are immediately behind each other, and at varying distances apart. Information of this nature would enable the floor and over-head bracing of open web girders to be determined with more precision than at present. It is usual to allow of a reduction of one-half as between the pressure on the windward and leeward girders in this country, and, I think, a similar practice is followed in America, but there appears to be no reliable ground for this assumption.

I think the pressures Mr. Smith instances as having destroyed buildings must have been greater than he gives them, as I presume they were deducted from the moment of stability of those structures, which would not take into account the reduction in velocity from friction in passing over the ground. In my own practice, when determining the strains on roofs and other structures affected by the wind, I take the wind as exerting, in a horizontal direction, a pressure of 30 lbs. per square foot, and I think this agrees with that adopted generally by English engineers.

In my opinion it must be admitted that the ground plan of a metallic skeleton pier, which is a parallelogram, is the one best suited to resist the strains, both vertical and lateral, to which it is exposed, and that the columns should be placed at its four corners in preference to the complicated grouping of the columns, as illustrated by the Crumlin and Fribourg viaducts. The question of whether the base of the pier should be spread out so as to have no tension strains at that point appears to me to be one largely governed by the question of cost and local circumstances, for if a pier is to be placed in a navigable channel, or in deep water, it is desirable to keep down the dimensions of the coffer-dam or caisson to the lowest possible limit.

Under these conditions, it would appear to be sound engineering to reduce the base of the pier and resist the tension of the iron portion by anchoring it down to the mason work, but when the masonry foundations can be provided without undue expense, the base should be enlarged so as to be stable without holding-down bolts, in the manner adopted by Mr. Smith in his remarkable bridge over the Kentucky River, and almost to the same extent by M. Nordling, in his viaducts on the Commentry & Gannat Railway, in France, where, at La Double, and other bridges erected by him at the same period, the total tension on the holding-down bolts is reduced to about 20 tons by the spreading out of the base in a lateral direction. The piers of the Kentucky Bridge are mounted on rollers both in the longitudinal and transverse direction, and it would be interesting to know to what extent movement has taken place from expansion and contraction at the foot of the piers.

The high pressures registered in Great Britain are those recorded by Mr. Hartnup, at the observatory at Bidston, and through the courtesy of that gentleman I am able to give the following particulars of the great storms of wind that have passed over that place between the years 1868-79:

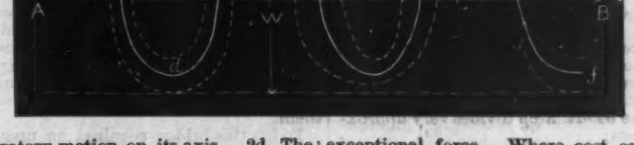
Date of Observation.	Greatest velocity in miles between any hour and the next hour following.	Greatest pressure in pounds on the square foot.	Direction of wind.
Dec. 27, 1868	92	80	W.
Oct. 13, 1870	82	65	W. S. W.
March 9, 1871	79	90	W.
Sept. 27, 1875	81	70	W. S. W.
Nov. 23, 1877	80	64	W.
Dec. 28, 1879	59	38	S. W.

The velocities were registered by Robinson's anemometer, and the pressures by Osler's anemometer. For the last 30 years I have resided within a couple of miles of the observatory and am well acquainted with its surroundings, and having regard to the high pressures recorded, I think they can only be regarded as having been of momentary duration, and of an entirely local character, for if the storms that gave rise to them had partaken of the cyclonic character of those enumerated by Mr. Smith, the houses in the neighborhood of the observatory must inevitably have been blown down, and no such a calamity has occurred in the district during the period I have mentioned, which is the strongest testimony that can be adduced in support of my opinion. If further evidence were required, I might state that I have been connected with a railway that has its terminus about 3 miles from Bidston for the last 25 years and during this period no cars or freight trucks have been blown over, and as these have a stability of from 30 to 40 lbs. per square foot, they cannot have been exposed to gales of wind with pressures ranging as high as 90 lbs. per square foot. It may be of interest to the society to know that Bidston, where the greatest wind pressures have been registered in this country, is 3 miles from Liverpool, on the Cheshire side of the Mersey, and 2 miles from the Irish Sea, standing on an eminence about 200 ft. above sea level, being at the same time exposed to the full force of the wind from all quarters of the compass.

G. BOUSCAREN, M. A. S. C. E.—I wish to preface these remarks with thanks to Mr. Smith for his very valuable contribution on a most interesting subject, in regard to which so little is known by the best informed.

The author has, I believe, stated correctly in his paper what American engineers' practice in regard to wind strain on bridges has been in the past ten years. The question to elucidate in this discussion is, whether this practice is sufficiently safe, when considered in the light of present knowledge on the subject of wind power, and in the face of changes now being introduced in the rolling stock and machinery of American railways.

First.—It seems that the information given, concerning tornadoes in particular, does not warrant the positive assumption that their width of area of maximum effort is less than the ordinary limits of bridge spans. From my own observations, the general movements of a tornado seem to be of four kinds.



1st. The gyratory motion on its axis. 2d. The advance onward in the general direction *A B*. 3d. An irregular oscillation to the right and left of the general direction, causing the axis of the vortex to describe a sinuous track *c d e f* which, as stated by Mr. Smith, gives an apparent breadth of swath *W* much larger than the width *T* of the actual track.

4th. An irregular vertical oscillation, causing the width *T*, which measures the diameter of the vortex, to vary constantly, and to such extent as often to disappear altogether, the tornado jumping up, as it were, for a time, and leaving unharmed for a certain distance directly in its course objects of comparatively little resistance. If I am correct, the small observed width of the St. Charles tornado may be very reasonably explained by the supposition that the cone was well up in its vertical course when it struck the bridge. The margin between the pressure assumed in our calculations and the highest pressure on record deduced from actual failures of structures seems sufficient, but there is, nevertheless, reasonable room for doubt, which can only be dispelled by numerous and well-directed observations.

The knowledge of the relations which the pressure of the wind bears to its velocity and to the shape of surfaces exposed is an important factor in the problem, but the great desiderata are accurate measurements giving the greatest effort actually exerted by the wind on the largest area.

Second.—Mr. Smith makes the pressure per square foot necessary to upset a fully loaded freight train 56½ lbs.; this can scarcely apply to prevailing railway practice at the present time. Box cars being now made to carry 20 tons and over, it would not be safe to reckon on a train load of less than 1 ton per lineal foot behind the engine.

This, with an exposed surface of 10 ft., and a heighth of 6¼ ft. from center of pressure to top of rail, which are maximum figures, gives for the upsetting pressure per square foot 60 lbs. for 5-ft. gauge and 75 lbs. for 4-ft. 9-in. gauge. Now, it is true that a train would not run under a wind approximating such a force, for the tractive power of the locomotive cannot overcome the train resistance with the additional friction of the wheel flanges against the rails, but the sudden apparition of a tornado, surprising a train moving or standing on a bridge or viaduct, makes it quite *possible* that the structure be subjected, with a train on it, to a pressure approaching 75 lbs. per square foot, should the wind reach such a pressure. At all events, one conclusion is very clear to me. We *know* positively that empty cars may be upset by the wind; this eventuality should be met with sufficient provision to resist it, in the design of bridges and viaducts.

Third.—It is undeniable that the rule of *no tension* in the columns of piers, with a good anchorage as an additional safeguard, is all that could be desired with reference to safety; but I do not think that it should be made absolute; in extreme cases it might involve a large additional outlay for masonry. With wrought-iron columns well spliced, I do not see the objection of utilizing the masonry (with a large additional excess of weight) to resist the tension due to wind-storms of exceptional force. Where cost can be reduced without sacrificing safety, it is not only legitimate but imperative to good engineering to do so.

Fourth.—In regard to the maximum strain per square inch allowable under wind pressure, my practice has been 15,000 lbs. in tensile members, and as given by Mr. Smith for other parts, being equivalent to an addition of fifty per cent. to the maximum strains under the normal load. I have now come to the conclusion that this is too much, and in the future will only allow 12,500 lbs. per square inch in tension. My reason for doing

this is the strains arrived at by calculation suppose that the force of wind is applied gradually; the strains due to the same wind, if applied suddenly (as would happen to a more or less extent in the case of a tornado), might be doubled in value, and reach 30,000 lbs. per square inch, which is beyond the limit of elasticity of ordinary bridge iron.

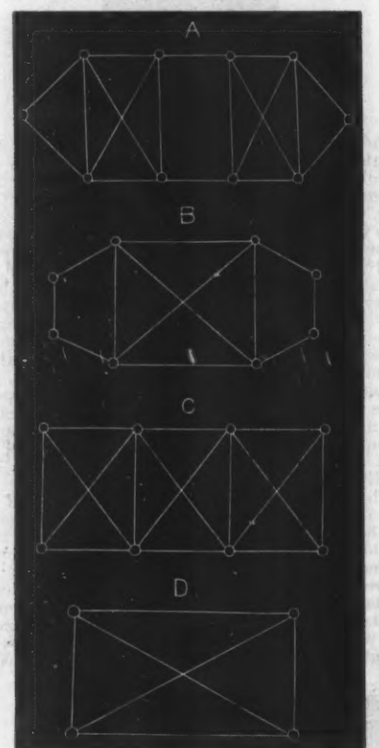
In conclusion, I beg leave to put in a few words in behalf of our European brothers. It is but proper to say that the ground plan of skeleton pier *A* given by Mr. Smith, as representative of the European type, is far from being generally used on the Continent. I do not know of a single case in France. Of the six French viaducts described by M. Nordling in his work, three are of the type *B* and three of the type *C*, of which is also the viaduct at Fribourg, in Switzerland, built by a French firm.

It is true that the piers of these structures are of cast iron, but it must be remembered that they were all designed prior to 1864, at which time the use of cast iron in columns was universal. This practice is now abandoned, at least by French engineers.

The bridge over the Douro, erected in 1877 by M. G. Eiffel, and the Garabit viaduct, now being built by the same engineer for the Marvejols & Neussargues Railway, are good examples of the present practice.

The piers in both structures are of the type *D*; the columns are of wrought iron; they are rectangular in section, closed in the Douro plan, and open, with lattice-work on one side, in the Garabit plan.

The practice, in regard to wind strain is to assume a pressure of wind of 35½ lbs. per square foot on the structure with a train on, 64 lbs. per square foot on the structure without a train on, and take the highest results. The maximum normal strain allowed, which is about 8,500 lbs. per square inch in tension, includes the strain due to the wind, which is often a considerable portion thereof. In the Garabit viaduct, for instance, the strain per square inch on different members of the 540-ft. arch divides very approximately as follows:



	Strains per square inch in lbs.			
	Due to dead weight.	Due to rolling load.	Due to wind.	Total.
On the chord of 540′ arch..	2 833	2 833	2 833	8 500
On the web " " " ..	1 400	1 400	4 200	7 000

Willard S. Pope, M. A. S. C. E.—The paper by Mr. C. Shaler Smith is a valuable addition to the stock of information on effects of wind. The provisions as to construction of bridges which his specifications call for, accord, I think, with the best practice of American bridge engineers of the present day. A structure designed and fairly built in accordance therewith will, doubtless, be safe as against the *lateral* pressure developed by any wind. But there is also a *vertical* tendency to be provided for. The effects of a whirlwind may be not only lateral, but also, under certain conditions, upward. Every one has noticed how the little eddies pick up dust and straws in the streets. I have seen on the plains of Wyoming and Colorado columns of dust, doubtless 200 ft. high, with distinct and sharply defined outlines moving majestically over the ground, held within the vortex of a whirlwind. Ocean navigators tell of vast masses of water, weighing hundreds of tons, thus lifted up into the air, like great vertical pillars.

The mere upward spiral whirl of the disturbed air is probably insufficient to develop this tremendous vertical energy. It may, perhaps, be supposed that the central core of the tornado is a vacuum, more or less complete, formed and sustained, possibly, by the centrifugal power of the gyrating particles of air; and as the open base of this cylindrical, vertical, vacuous column trails along the surface of the earth, movable matter exposed to its influence rushes upward into it with a velocity and momemtum due to atmospheric pressure as well as to direct force of wind. Roofs of buildings are frequently lifted off, although the only exposure to actual upward wind pressure is at the projecting eaves and cornices. But suppose this vacuous column passing over the building! with what explosive force the confined air within would shoot the roof upward and the walls outward!

The existence of this vacuum seems essential to explain some of the phenomena connected with tornadoes; and if such vacuum really occurs it must develop a tremendous force vertically, just as the wind itself develops a force horizontally. That such upward force may destroy a bridge I have some evidence. About 1858 a railroad, of which I was engineer, lost a bridge by wind. It was a wooden, through Howe truss, in two spans of about 100 ft. each, with the chords framed together over the central pier. The bridge was not roofed or covered. The location was such that the structure was well sheltered by timber, and from the underside of the bridge to the surface of water in the stream it was only about 15 ft.

The direction of the bridge line was east and west and the storm passed from north to south.

When I reached the scene of the disaster, a few hours after it had happened, I found the spans in the river badly wrecked, of course, but still continuous, and in tolerably fair line. The west end laid at the base of the west abutment, the central part just cleared the southerly end of the pier, while the east end laid probably about 20 ft. southerly from the east abutment. The bolsters underneath the ends of the lower chords had been, when built, shouldered about two inches into transverse wall-plates of oak. These wall-plates (which had not been bolted to the masonry) were still lying in their places on both the east abutment and the pier, while those of the west abutment had been dragged into the river. If the spans had been tipped over, or had been slid off the masonry, by the horizontal force of the wind, they would certainly have taken the wall-plates with them. On the east abutment there was no sign of a blow from falling timber. There happened to be a joint in the track rails on the bridge within three or four feet from the east end. The ends of the bank rails were still protruding out over the edge of the abutment, and the ties attached to them had evidently been raised vertically from their beds in the embankment.

If the east end of the bridge had been lifted up bodily, and thereupon been moved 25 ft. or so southerly, turning on the west abutment as on a pivot, and then dropped into the river, all these appearances would have been accounted for. I could make no other hypothesis that would explain them.

To lift this bridge required an upward pressure of about 80 lbs. per square foot of exposed surface. This is on the supposition that the floor system was bolted to the trusses, which was the fact.

Applying this to a modern iron bridge of, say, 160 ft. span, the horizontal surface of the iron work only is, say, 9 sq. ft. per lineal foot of bridge. An upward pressure of 80 lbs. per square foot would amount to 720 lbs. per lineal foot. And as the iron work will weigh, say, 1,100 pounds per lineal foot, the structure will be safe. But the flooring thereon (for a railroad bridge) exposes, say, 11 sq. ft. of horizontal area per lineal foot. This, at 80 lbs. per square foot, amounts to 880 lbs. per lineal foot, to counterbalance which is only about 300 lbs. of dead weight of flooring. The upward pressure, therefore, on the two combined will be, say, 1,600 lbs., while the total resisting weight will be but 1,400 lbs.

The moral is, do not bolt the flooring firmly to the trusses.

If this reasoning is correct for railroad bridges, much more does it apply to highway bridges, where the area of flooring is generally much greater proportionately.

Joseph M. Wilson, M. A. S. C. E.—Mr. C. Shaler Smith's interesting paper on wind pressure seems to pretty well cover the subject, so far as present information on the matter allows, and agrees essentially with my own practice, except that in taking wind pressure at 30 lbs. per square foot on vertical bridge surface with that on train at 300 lbs. per foot lineal, I have been in the habit of taking only one truss, and have usually not exceeded the ordinary limits of working stress, such as 10,000 lbs. per square inch tension on wrought iron, etc., etc., and also have not taken the pressure on the train as a moving load. I fully agree with Mr. Smith as to the propriety of taking this as a moving load, and also as to increasing the limiting stress; but in doing so, I should, as he does, take twice the vertical surface of one truss, and should be inclined to make my pressure 40 lbs. instead of 30, in very exposed localities.

The addition of an initial stress to allow for strains produced in screwing up the rods is a good point.

In some of our exposed buildings we have taken 25 lbs. per square foot of surface on one side with no increase in working stress over ordinary limits, but in later work have adopted 30 lbs., with an increase in allowable stress of about one-third.

I should be glad to see some more reliable observations made on the matter of wind pressures at a point where high velocities are attained—Mount Washington, for instance—the question of surfaces of different forms being considered, such as concave, convex, and those given by I beams, channels, etc. Also the loss of effect caused by the wind passing through the openings of one truss on to another, etc.

While I agree, of course, with Mr. Smith that the American form of trestle is decidedly preferable to the European form, still I think his criticism on the latter is a little severe, as the column *a* must be prevented from collapsing in the direction *c d*, at least to a great extent, by the bracing connecting it with the two adjacent columns of the trestle, and forming a triangle in horizontal section if such bracing is made heavy enough.

A. Gottlieb, M. A. S. C. E.—The views of Mr. C. Shaler Smith, with reference to wind forces and wind strains, as stated in his paper, meet my own views in every respect.

I believe that a wind pressure of 30. lbs. per square foot on the side of a train, also on the whole surface of the windward and such portions of the leeward truss as may not be moved by the train, is sufficient for the safety of structures.

I have no doubt that winds of a greater force than this occur, but considering that the are very exceptional, and, as Mr. Smith states, their paths are narrow when they occur, I do not think it necessary to provide against larger wind forces than 30 lbs. per square foot, certainly not for spans over 200 ft.

One point I believe, however, Mr. Smith has not treated as fully as its importance calls for.

Every one of us has seen structures and bridges erected, with parts proportioned correctly to resist specified live as well as dead loads, as far as the sections of the members were concerned, and still the structures were failures, owing to defective details in the connections. So it is also with the members intended to resist and to transmit wind strains, and, I might say, in a still higher degree.

Engineers generally pay too little attention to this most important fact, and the consequences are twisted struts, bent pins and distorted chords; although the sections of these members, intended in the first place to resist wind strains, may even have been excessive.

In connection with this, I will state that I think it advisable that the sections of the bottom chords of spans over 200 ft. should be increased to resist the horizontal strains from wind strains.

The usual practice is to provide for the strains arising from live and dead loads only in bottom chords, disregarding entirely the additional tensile strain, which is brought to act on one line of chord from the lateral rods.

I find that with the usual live load of two loco-

motives followed by cars, and a wind force of 30 lbs. per square foot, the additional stress in one line of bottom chord produced by the lateral rods over and above the strains derived from live and dead load combined, is for—

Spans of 100 feet, about 25 per cent.
" 200 " " 40 "
" 400 " " 50 to 60 per cent.

Taking the working strain in members of wind bearings and their connections 50 per cent. larger than for the vertical loads, the increase of section required in bottom and chords would be:

For 100 ft. spans, 16 per cent.
" 200 " " 26 "
" 400 " " 33 to 35 per cent. } Over and above the section usually given.

I believe that in all spans in which the section of bottom chords, required to resist wind strains, should exceed the section provided for live and dead loads by 25 per cent. or more; this additional section should be given the chords, particularly as it could easily be done without increasing the dead weight of the structures materially.

The Chicago & Alton Railroad has lately adopted the rule to increase the section of every member of the bridge on account of wind strains, even floor beams, track stringers, top chords and posts. I believe this unnecessary, and rather detrimental to the structures, as it increases their dead weight, without adequate benefit to compensate for it.

D. J. WHITTEMORE, M. A. S. C. E.—This paper will have done excellent service, aside from that due to its merit, if it will cause others to contribute such facts as to extent and ultimate concentrated force of tornadoes, as may come clearly and definitely within their knowledge. It appears to me that the same practice in designing structures to resist wind strains should prevail outside of the present known tornado belt that should be employed within it. Some eighteen or twenty years ago a tornado swept over and destroyed the village of Viroqua, Wis., and in the supposed path of greatest effect carried wheat straw with sufficient velocity to cause it to penetrate through the one-half inch pine siding of a destroyed dwelling house, and the piece of board with the straws sticking through it is now in existence at the place mentioned. Who has the data from which to calculate the force required to cause this effect?

While our bridge experts generally conform to about the specifications set forth in Mr. Smith's paper there are many designers and builders of structures who do not, some in this country and some abroad. I would call members' attention to a recent volume of the "Proceedings of the Institution of Civil Engineers"(Vol. LXI, p. 190), which contains a description of a viaduct built across the Clyde, at Glasgow, in 1878, which clearly shows the difference between English and American practice in regard to wind bracing. The viaduct carries four tracks and consists of five spans. Each span has two riveted lattice trusses placed 50 ft. apart, center to center, plate floor beams at the panel points, riveted stringers under each rail, and a

floor covered with Mallet's buckle plates. The longest span is the part of the work I chiefly wish to refer to; its trusses are 199 ft. long, 20 ft. in depth, and the floor beams apparently rest on and are riveted to their bottom chords. The panel length is 10 ft. Both top and bottom chords are built up of plates and angles, as sketched, and the iron in them is strained to four tons (8,960) per square inch by the calculated loads both in compression and tension.

The description of the top lateral bracing, is as follows (p. 197): "The tops of the girders over the river are connected by cross bracing 20 ft. apart. These braces are light lattice girders, having the upper boom fish-bellied. They assist to stiffen the viaduct, but the object for which they were erected was to support smoke-boards which were erected, at the instance of the Clyde Trustees, to prevent sparks flying on to the shipping below."

From this we would infer that the writer of the paper thought that this span did not require any top lateral system, as he states that the cross bracing was put in to carry smoke-boards. Without lateral bracing the top chord would be a column of over 60 diameters, strained to nearly 9,000 lbs. per square inch, and the stability of the trusses would chiefly depend on their connection with the floor beams, which are only 16¾ in. deep at the ends where they are riveted to the bottom chord.

It is impossible to estimate the stiffness which this arrangement gives to the structure without seeing the exact detail of the joint, and this is not given in this paper. But there can be little doubt that strong top lateral and portal bracing would greatly increase the strength and durability of the bridge.

A. S. C. WURTELE, M. A. S. C. E.—I have read with interest the advance copy of paper by C. Shaler Smith, on "Wind Pressure on Bridges," and consider it a full statement of a subject which has not received sufficient attention; my experience, from examination of plans as consulting engineer, being that the additional strain in chord members, due to wind pressure, is quite neglected.

I know of no definite results as to the effect of such pressure on open lattice work, but do not think it equal to the actual surface, for while lowering a 60 lb. span lately, during a high wind, I found the guy lines only slightly strained, the support being only two long jacks at each end.

From the double bearing the calculation of swing strains is indefinite and comes under the class of imperfectly fixed trusses, so that a complete reduction would give rather a fanciful result; but it is best to assume the worst condition of one side only fixed.

I prefer to use the same specified strain as for a load with a lesser wind intensity, so as to get sections of combined strain at one operation—at 20 lbs. pressure would equal 50 lbs. before elastic limit would be reached under load strains.

CHAS. A. SMITH, M. A. S. C. E.—I have observed, when standing upon high bridges and other exposed situations, that very frequently the wind came in regularly recurring periods or pulsations. In three instances at St. Charles, and one at Plattsmouth, the interval between pulsation was about one second. These were not the irregular gusts which, of course, occurred, but continued for hours. It is possible that such action of the wind could produce oscillations in the structure itself, if the periods agreed with that of lateral vibration, or if one was a multiple of the other.

Concerning the values used it would appear that the pressure recommended by Theodore G. Ellis, M. A. S. C. E.,* and adopted by F. Slataper, M. A. S. C. E., would be preferable to members of the community who are not manufacturers of bridges, and also would give a better margin for the effects of vibration and that unknown element, viz., the lateral force required to keep a long compression chord in line, which is theoretically nothing if the chord is in line, and which increases with the allowable deviation. If the 30 lbs. allowed be enough for the wind, does it include this effect or not, and will not the higher value of 40 lbs. give a structure with less lateral vibration? The amount of metal in question is not very great, and the life of the bridge must be increased thereby.

(TO BE CONTINUED.)

THE PANAMA CANAL.

ASPINWALL, Sept. 16.—In spite of all the glowing accounts published in the canal interest business is duller on the isthmus than it has been for years. Some of the large houses say that they are doing almost nothing. Small traders are flocking in, flooding an already over-stocked market, and the effect can be imagined.

Our cable being broken again we have heard no news as to how the first annual meeting of the Canal Company came off in Paris or whether De Lesseps has got another $15,000,000 for his South Sea Bubble. Not a thimbleful of earth has left its virgin couch as yet—not any. A number of prominent officials leave on the steamers of the 16th and 24th of the Pacific Mail Company. To-day it was reported that work will be suspended for two months, until they are ready to begin the excavation, but this is not confirmed as yet.

The *Bulletin du Canal Interoceanique* still publishes a series of Aladdin-like stories of the great and wonderful things done here, but we poor benighted Isthmanians, with only two eyes apiece, have failed to see the same.

A long-headed and longer-legged Pacific Mail captain made a remark worthy of Hippocrates the other day, referring to the disease and death among the canal employés. He said: "There will be more dead Frenchmen here soon than at Waterloo." Enough to make one regiment have already found "permanent locations," poor fellows!

The *Canal* of Panama is very busily engaged in translating and reproducing your correspondent's articles in French. So, thank goodness, French readers in Paris can at last get a few truths about the isthmus. The *Canal* does not attempt to deny the accuracy of the letters; but gets off a little indifferent sarcasm about the "touching solicitude of the world" for the French on the isthmus.

Mr. Harel, a brother-in-law of Mme. de Lesseps, leaves the isthmus on a summons from the canal company in Paris to represent his side of a curious shindy which has taken place among the chief employés of the company here. He will be followed shortly by the "party of the other part" in the shindy, Mr. Armand Reclus. The facts of the case are substantially as follows: Some time ago, when nearly the whole of the canal staff were living at the Grand Hotel in Panama, Mr. Harel entered the dining-room one day, carelessly dressed, and in fact wearing his working suit, consisting of a kind of blouse and loose trousers. Thus equipped he walked up to the official table as they called it, where the superior agent, Mr. Armand Reclus, was seated with the principal members of his staff, and was about to take his seat. Mr. Armand Reclus, feeling himself personally insulted by Mr. Harel's unseemly dress, ordered Mr. Harel to leave the room, which was filled at the time with the other guests of the hotel. Mr. Harel resented the order given to him, and a magnificent row began, which lasted for some time to the great annoyance of the rest of the company. All this was duly reported to Paris by Mr. Reclus, who demanded the recall of Mr. Harel. This put the canal company into a very awkward fix. They did not dare to remove Mr. Harel, he being the brother-in-law of Mme. de Lesseps, neither could they afford to displease Mr. Reclus, who is the chief agent here, and whose brother is a very prominent French politician. So orders were issued from Paris for a suspension of hostilities, and Mr. Henry Bionne, the general secretary of the canal company, was sent out here specially to smooth matters over. Now it seems that the matter as reported on by Mr. Bionne was not satisfactory to the Paris magnates, hence the calling to France of Messrs. Reclus, Harel, et. al., for a species of court-martial in Paris. Mr. Reclus' retirement is probably only a question of time.—*Correspondence N. Y. World.*

MEXICO.

In view of the railroad projects in Mexico, everything relating to that country has a present interest. Our consul at Vera Cruz writes that very little cereals are grown in his district; cotton is considered extremely uncertain, from the many enemies and accidents to which it is exposed; cane, sugar, molasses and alcohol therefrom have been under discouragement, although previously most promising, by the enforcement of a local toll or discriminating tax put on that especial product. Agricultural instruments used are of the rudest and Biblical class, and all attempts to modernize them have failed. One hardware firm in Vera Cruz has had an American plow on sale for years, without a bid, and could not probably find anybody to take it as a gift on agreement to use it. Manufactures consist of two cotton mills, two paper mills and a large but unknown number of concerns making cigarettes. The paper mills make printing, wrapping and a poor grade of writing paper; but with all the advantages of cheap labor and abundant water power, and the large profit consequent upon an enormous duty, neither quality nor quantity of product is up to the market demand. During the past ten years the deaths in Vera Cruz were 12,219, or an average of 102 per month; the mortality was greatest among the males—7,714, to 4,505 females. In 1869, however, females predominated in the population, there being 7,408, and 6,084 males. The greatest mortality was of children under five, and on the basis of the 1869 population only about eleven years are required to exhaust the entire population living at any one date. Upon the basis of about 14,000 for present population, the mortality seems to be at the appalling annual rate of 50 in 1,000. Many articles, such as flour, canned goods, potatoes, etc., could profitably be brought in were not the duties prohibitory—for example, $8 a barrel on flour; these high rates on staple articles make living very expensive. Of the operation of the tariff the Consul at La Paz writes that trade is diminish-

ing at that port. No foreign vessel except the monthly mail steamer had entered the port for four months, and foreign trade appeared at an end. Six months later (April 20 last) he wrote that all meats are put out of reach by the duties; that, on the 75 cents to $1.50 per day paid, laboring men can barely wrest a miserable subsistence, with flour 10 cents a pound, sugar 20 to 25, butter 50 to 75. La Paz had a very good wharf, built by the government some fifteen years ago; but as the government would neither allow wharfage to be collected nor furnish funds for repair, the wharf has recently broken down; the prospect of ever rebuilding was slender, and vessels will hereafter have to discharge into lighters as in the old times. He ascribes the decay to the tariff and the outrageous penalties enforced for any violation; fines and fault-finding are so thick that the merchant would not dare import, had the people any money to buy; a recent law exposes him to imprisonment as well as fine. The Vera Cruz Consul cites figures showing a handsome commercial increase there, and attributes it "to the long period of peace the country has enjoyed, it being almost three years." The Matamoras Consul also reports that that part of the border has now enjoyed more than three years of quiet, with unusual indications of a continuance of it. From all this it appears that Mexico is rather "a sick man," and is unlikely to become swiftly a commercial Canaan for this country.

NOTES.

Aniline Dyes.

In the general term aniline are embraced the varied and brilliant coloring materials procured chemically from the results of dry distillation of coal-tar. In Switzerland, although the material is all drawn from Germany and France, this aniline industry has grown to important size during ten years past, the combined product of four large establishments in Basle and one in Geneva being some four million dollars in value. The exports to this country began three years ago from Basle, and show a rapid increase. The processes are jealously guarded, and access to the laboratories is denied; hence statistics are not easily obtained. Many of the operations are of great delicacy, depending upon exact conditions of temperature and nice combinations of ingredients; hence there is a demand for the highest skill in practical chemistry, which is stimulated not only by salaries of $2,000 to $10,000, but by premiums on discoveries that produce new shades practically. The German and Swiss universities offer special courses of study in aniline chemistry, and our Consul at Basle says that dyes have been produced from coal-tar which are fast supplanting such standard coloring materials as safflower, cochineal, turmeric, kermes, and several tropical dye-woods. Even a perfect substitute for madder has been produced, and the culture of that plant, hitherto worth some twelve million dollars a year to France, Italy, Holland and the Caucasus, is threatened with extinction; and the aniline chemists have at last found a perfct substitute for indigo. As these colors are applicable to dyeing almost every material, and their use is necessarily growing, it is a most suggestive fact that they can be produced as well from the residuum of petroleum refining as from coal-tar itself. One of the largest makers of dyes in Switzerland has formed a partnership with a Swiss chemist for establishing a laboratory in this country for working the residuum of the oil refineries, the chemist having dircovered a valuable process for that purpose. The capital required in Switzerland to set up a good-sized laboratory is about two hundred thousand dollars. As the raw material is on the spot here, and nearly every chemical used is cheaper here than in Switzerland, this adds another to the wonders of petroleum, and suggests a new and expansive industry for this country.

Dead Sea Water.

A German chemist has made an analysis of the salts that are dissolved in the water of the Dead Sea. The result leaves hardly a doubt in his mind that this lake, traversed as it is by the Jordan, and fed chiefly by it, owes its peculiar water to a rock-salt bed, and, in the first instance, to the upper layers, which contain much magnesia. In a litre he found the following substances in the proportions named: Chloride of potassium, 16.9 grains; chloride of sodium, 74.051 grains; bromide of sodium, 5.024 grains; chloride of magnesium, 128.105 grains; chloride of calcium, 35.355 grains; sulphate of lime, 1.211 grains—a total of 260.646 grains of salts.

Protection of Submarine Cables.

At a sitting of the Electric Congress question was raised in regard to the rights of property in submarine cables. At present no government has jurisdiction beyond three miles from the coast, and the cutting of a cable beyond that distance is not a criminal offense. Dr. Siemens, the well-known cable manufacturer, strongly urged the importance of giving some protection to such valuable property as cables. A suggestion of M. Cockéry, the French Minister of Posts and Telegraph, that representations on the subject be made to the different governments was agreed to.

FOREIGN INTELLIGENCE.

Spain contemplates laying a cable to the Canaries.

Herr Krupp, of Essen, has accepted a contract for the exportation of 25,000 tons of steel rails to the United States.

The subterranean telegraph system, connecting 221 towns and cities of Germany, is now complete. The total length of buried cable is 5,500,000 kilometers (3,300,000 miles).

The headings of the two sections of the railway tunnel under the River Severn connecting the coasts of Monmouth and Gloucestershire have met with a deviation of only three inches. The work has been in progress seven years.

A ukase has been published at St. Petersburgh sanctioning the construction of the Latcha-Kubensky Canal, which will establish a connecting line between rivers flowing into the White Sea and the Baltic and tributaries of the Volga.

A sample of water from the sacred well of Mecca has been analyzed and found to be polluted by sewage to an extraordinary degree of disease-breeding filthiness. In fact, Professor Frankland, who made the analysis, declares that it is nothing less than bottled cholera, and, as this water is in great demand throughout Mohammedan countries, it is manifest that it is likely to be an active agent in the dissemination of disease.

GENERAL INTELLIGENCE.

☞ *We solicit and are always pleased to publish in these columns any items of interest that may be furnished us.*

GAS AND WATER.

The work of developing the water power on the Housatonic River, 2½ miles south of New Milford (called The Falls), will be commenced this week, and pushed forward as fast as possible. This very valuable water power has lain from the creation at rest, until the Bridgeport Wood Furnishing Company, Hon. Nathaniel Wheeler and W. H. Perry directors in the company, purchased it. The plan of development was made by B. H. Hull, of this city, who will see them executed. The company will utilize about 600 *H.P.* for themselves.

BRIDGES.

The Indianapolis & St. Louis Company are pushing the work on the new bridge across White River and expect to complete it by October 7 so near that trains can run over it.

RAILROADS.

The contract for building the first twenty-five miles of the Fort Worth & Denver City Railroad was let on the 27th ult.

Contracts for a large proportion of the Boston, Hoosac Tunnel & Western line through New York State will, it is understood, be let within a few days.

The Wabash people are expending $1,500,000 in terminal facilities at Detroit, and by May 1 will have a new passenger and an immense freight depot ready for business; also extensive wharfage facilities.

Articles of association of the Laporte & Illinois Railroad Company have been filed with the Indiana Secretary of State. The road will extend from Laporte west to the Indiana state line, a distance of fifty miles. The capital stock is $1,200,000.

The Keystone Bridge Company is doing an extensive work on the P., C. & St. L. lines, replacing wooden with iron bridges. The P., C. & St. L. people this year are expending a large sum of money in this character of improvement.

Havana, Sept. 29.—The government of San Domingo has given a concession to Edward B. Hall to establish a railroad between the capital and Azua, with the exclusive right to extend the line to San Juan and Neyva, or other points on the frontier.

President Dillon reports that 100 miles of the short line projected to run from Granger to Portland, Oregon, have been graded, and 25 miles of the track laid, and it is intended to lay 100 miles of the track between now and December. In the spring the road will be extended to Oregon.

Albany, Sept. 29.—Articles of incorporation of the Allegany Central Railroad Company were filed here today. The road will run from Friendship, Allegany County, to Swain station, on the Buffalo Division of the New York, Lake Erie & Western Railroad. The capital of the company is $1,000,000.

Track-laying is going on at the rate of four miles per day on the New York, Chicago & St. Louis road. Track-laying is going on between Cleveland and Fort Wayne, east of Valparaiso, Ind., and 100 miles of track is already laid between Cleveland and Buffalo, and the whole road will be ready for operation by July 1, 1882.

The survey and final location of the Baltimore & Ohio Railroad Company's proposed line from Baltimore to Philadelphia is now finished from Baltimore to Wilmington, and the engineers have just begun work on the line from Wilmington to Philadelphia. The line is generally to the westward of the Philadelphia, Wilmington & Baltimore.

Track on the Western North Carolina road is now laid from French Broad Station, up the French Broad River, to the mouth of the Ivy, a distance of five miles, making the road 160 miles long from Salisbury. The bridge over Ivy Creek is nearly finished, and track will probably be laid two miles further, to Marshall, in a few days. The work on this section is heavy, including much rock-cutting. From Marshall to Warm Springs, 16 miles, there is some heavy work, but a large part of it is finished.

Cleveland, Sept. 29.—Work on the New York, Chicago & St. Louis Railroad has never proceeded so rapidly in any week since its commencement as it has during the last week. More than 100 miles of grading has been completed on the Erie Division, extending from Cleveland to Brockton. The masonry work has also been so far advanced that it will all be completed in three weeks. It is expected that matters will be in such shape by the beginning of winter that the cold weather will not prevent the finishing touches.

Saratoga, Sept, 29.—The Adirondack Railroad was sold on a mortgage foreclosure to-day for $350,000. The purchasers were Messrs. W. W. Durant and William Sutphen, the trustees of the road. The Adirondack Railroad is completed to North Creek, and has been running for several years. The mortgage was for $6,000,000, and there was accrued interest amounting to $3,600,000 more. The mortgage covered a large amount of lands in Warren, Essex, Franklin, Herkimer, Hamilton and St. Lawrence counties, beside the railroad.

The iron trade last week was active, there being no abatement in demand or prices. The markets abroad are firm and advancing, and there are indications both here and in Europe of still further enhancement of values. A sharp rise is anticipated, especially in pig iron, and there are apparently well founded predictions of extraordinary prices within six months. The boom in iron will naturally improve the already prosperous condition of the coal companies, both in mining and transportation. There are several iron works having their entire product contracted for until late next year.

Springfield, Ill., Sept. 27.—Articles of incorporation of the Effingham, Ramsey & St. Louis Railroad Company were filed in the Secretary of State's office to-day. The incorporators are: John C. Black, of Danville; Samuel W. Osgood, John W. Funkhouser, E. Pratt Buell and John J. Funkhouser, all of Effingham. The capital stock is $200,000. It is proposed to build a line of railroad from Effingham to the intersection of the Illinois Central and Toledo, Cincinnati & St. Louis railroads. The principal business offices are to be at Effingham.

Springfield, Ill., Sept. 27.—The Effingham, Ramsey & St. Louis Railroad Company filed articles of incorporation in the office of the Secretary of State today. The proposed railroad is to be constructed from the city of Effingham to or near the place where the Toledo, Cincinnati & St. Louis Railroad crosses the Illinois Central Railroad, or some point on the Toledo, Cincinnati & St. Louis Railroad east of said road-crossing not exceeding fifteen miles. The capital stock of the company is $200,000, and the incorporators and board of directors are John C. Black, of Danville; Samuel W. Osgood, of Effingham; John W. Funkhouser, of Effingham; E. Pratt Buell, of Warsaw, and John J. Funkhouser, of Effingham.

San Francisco, Cal., Sept. 27.—A dispatch from Reno says: "A stockholders' meeting of the Nevada & Oregon Railroad Company was held to-day for the purpose of ousting some of the directors. When the meeting was called to order Frank F. Fowler stated that it was a stockholders' meeting, and requested all others to retire. No one moved, and he pointed to ex-Judge E. D. Wheeler, James McMeehan, of San Francisco, and Treasurer Coffin, of Carson, and told them that if they did not go out they would be put out. They still remained, and a rush was made. Pistols were drawn and fired rapidly, and S. C. Scovall, Secretary, and D. A. Balch, of San Francisco, were fatally wounded."

The Ontario & Western, and the New York, West Shore & Buffalo Railroad companies have made an agreement, by which the Ontario & Western turns over to the other company $10,000,000 of cash and all the rights they had in the route on the west bank of the Hudson River between Hoboken and Cornwall, and in the terminal grounds opposite New York. In return the West Shore Company agrees to build the road between the points named, and to give the Ontario & Western perpetual right of way over it, and perpetual use of the terminal facilities at Weehawken, and also hand over to the Ontario & Western an amount equal to its cash of 5 per cent. bonds of the New York, West Shore & Buffalo, and a bonus of 25 per cent. of its stock.